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A Wireless Based Temperature, Humidity and Light Intensity Monitoring System for Child Incubators

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ABSTRACT

This paper describes the design and the development of a wireless based temperature, humidity and light intensity monitoring system for child incubators. Similar systems are used extensively in developed countries. But due to cost limitation, in developing country like Bangladesh such a system is not used very much, rather human monitoring of premature babies in incubators by nurse is often used, which is very much prone to human errors. The proposed system will save time, cost and manpower. Although there are currently systems which are partially similar or collection of systems which, as a whole, achieves similar goals, the proposed system is more integrated in nature and thus more efficient in performance. The system consists of two parts, one is the transmitter and other one is the receivers which are connected through RF signals. This system is inexpensive and user friendly. It can be deployed in hospital and baby care units without incurring huge cost overhead.

Keywords:- Incubators:Temperature:Humidity:Light Intensity:Monititoring.

I. INTRODUCTION

Preemies are referred to as premature babies. Preemies are frequently affected by jaundice and problems related to hypothermia [1]. This proposed system in this paper focuses on improved monitoring of health conditions of preemies. Good Monitoring and health care system are essential for supporting premature babies in the infirmary. In a developing country like Bangladesh there is a lack of low cost health care systems. Ordinary infant care system provides only non-integrated monitoring and control. An individual and unified system usually leads to increased cost for their operation whereas the proposed system meets all the operational demands at a much lower cost. This baby incubator provides an ideal temperature, humidity and light intensity similar to that in the mother womb.

1.1Jaundice

Jaundice is a disease often expressed as the symptoms of yellowish color skin and white part of the eyes. It is a sign that there is too much bilirubin in the baby's blood, which is often referred as hyperbilirubinemia [2]. Mild jaundice is common in most of the premature babies (about 60%).It usually gets better or goes away on its own within a week or two without causing problems. But jaundice should be taken seriously. In rare cases, if the bilirubin level stays high and is not treated, it can cause brain damage which is called kernicterus. This can lead to serious lifelong problems. Generally the jaundice in new born babies does not need any treatment but some exceptional cases this jaundice can surpass the safe limit. For those cases the babies need to be kept in phototherapy, in which babies are kept under a blue tube light.

A. Heat Loss Mechanism

To prevent heat loss the most commonly used mechanism is a neutral thermal environment called incubator. In biology, an incubator is a device used to grow and maintain microbiological cultures or cell cultures. The incubatormaintains optimal temperature, humidity and other conditions such as the carbon dioxide (CO_2) and oxygen content of the atmosphere inside. It is more serious matter for the premature babies affected by jaundice.

A. Jaundice Treatment by Phototherapy

[2]Phototherapy refers to the treatment of jaundice by keeping the baby under blue tube lights. It is a process called photo-oxidation to decrease the level of bilirubin. Addition oxygen can change the substance that help dissolve easily in water. During phototherapy it is important to monitor babies' temperature to ensure that they are not getting too hot as well as not showing the signs of dehydration. Phototherapy is this method will be improved method for treatment of preemies jaundice with less chance of complication. It is an easy and convenient system to use.

C. Hypothermia & Repertory Problems in Preemies

[4]Pneumonia is an infection of the lungs, usually caused by a bacteria or virus. Some babies get pneumonia while they are still in the womb and must be treated at birth. The most common lung problem in a premature baby is respiratory distress syndrome and also known as hyaline membrane disease. Premature babies may not be able to have enough surfactant in their lungs making it difficult to breath. Normally a new born baby's breathing rate is about 40 times per minutes. This rate may slow down to 20 times per minute. In these cases a baby need immediate medical attention. On the other hand hyperthermia is a condition in which the body temperature is abnormally low. The infant's body temperature drops immediately after birth in response to the extra uterine environment. Premature infants have a

thin, underdeveloped stratum corneum or the rough, outer layer of the epidermis which protects the skin from external agents that enables excess of water to diffuse out. A low birth weight baby has decreased thermal insulation due to less subcutaneous fat and reduced amount of brown fat. Brown fat is the source of heat production. It is localized around the adrenal glands, kidneys, nape of neck; inter scapular area and auxiliary region. Metabolism of brown fat results in heat production. Blood flowing through the brown fat becomes warm and through circulation transfers heat to other parts of the body. [3]This mechanism of heat production is called non-shivering.

1.2. Motivation

Our proposed system introduces an environment which shows the heat loss mechanism benefit. The transmitting part of the system Arduino Uno Board is integrated with ATmega 328. The output of this system is implemented on a very small bread board that connects the sensors, light emitting diodes and the transmitter. The receiving part uses receiver which is also connected with the bread board. The receiver receives the ambient temperature, humidity and light intensity in the incubator through RF signals and the output is shown on a LCD display. In the monitoring section a Laptop also shows the output data using the LabView Software.

II. DESIGNS

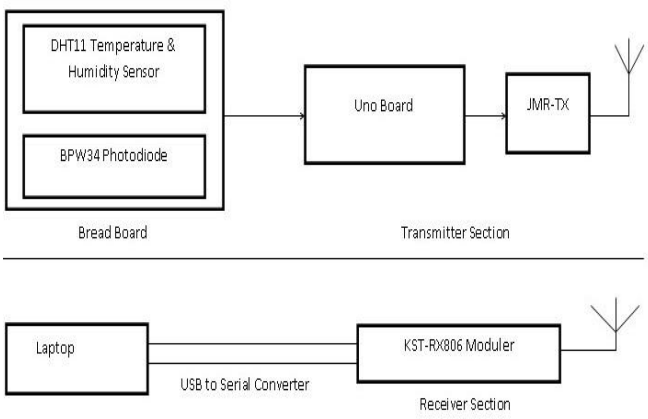

Figure1: The block diagram of the incubator monitoring system including both the transmitting & receiving sections.

2.1 Methodology

This proposed scheme aims at designing a wireless based monitoring system which supports the following parameters:

a) Temperature
b) Humidity
c) Light Intensity

Table: 1 Necessary Equipment Item List

Equipment Name	Description
DHT 11	Small size, low power and low cost digital temperature & humidity sensor. Supply power 3-5.5V.
BPW34	Extremely high resistance when reverse biased but its resistance is reduced when light of an appropriate frequency shines on the junction.
Arduino Uno Board	The Arduino Uno is a microcontroller board based on the ATmega328.It has 14 digital input /output pins,6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. It simple connects to a computer with a USB cable. It is powered with an AC to DC adapter.
KST- RX806	KST-RX806 is a wireless data transmit and receive module with VHF/UHF super high Frequency. Its operating voltage is +5VDC, current ≤8mA, frequency 315MHz - 433.92MHz receiver sensibility -115dB and storage temperature in the:-40℃ to ≃ +85℃.
JMR-TX1	It consists of a power amplifier, a one-shot circuit and a phase-locked loop with internal voltage control oscillator and a loop filter.

III. OPERATING PRINCIPLE

Arduino Uno Board has an ATmega328 circuit. BASCOM-AVR is used to program on the UNO board. Bread Board is used to place all the equipment with connecting wires. A USB to serial converter is connected with the laptop to the KST-RX806 Module. On the incubator section the Arduino is mounted on the bread board is connected. A 12 V adapter is connected with the Arduino Uno Board. The LCD display is connected with Arduino board. DHT11, Photodiode BPW34 and TX are connected on bread board. The LCD display is showing the room temperature, Humidity the light intensity. If a fan is attached with this incubator or an AC the humidity will be changed .If extra light ray is incident on the photodiode the value will change.

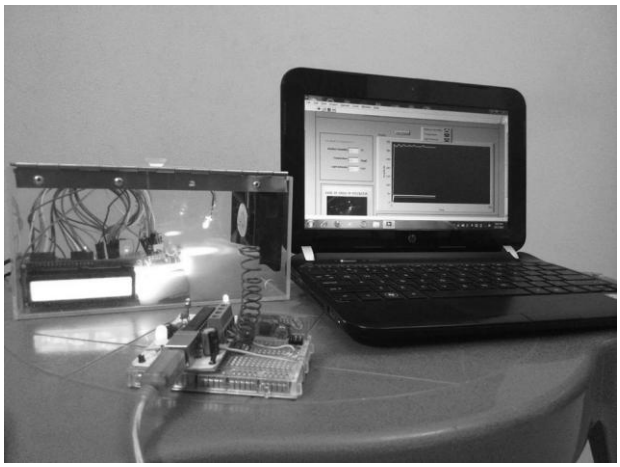

Figure2: The picture of whole system.

The whole system is connected through RF signals. LabView is used to monitor the parameter from monitoring section.JMR-TX1 modular is used for transmit. Here It is showing the Room Temperature=31 degree Celsius,

Humidity 43% and Light Intensity = 331 Lux. It works within a range of 150M. The result shows that the temperature and humidity will vary due to some environment changing. The light intensity will change every two seconds. In the monitoring section a baby incubator is shown. Here multiple incubators can be added. One does not need to stay physically close to the incubators for monitoring. A person can monitor from far from the incubator and make decisions.

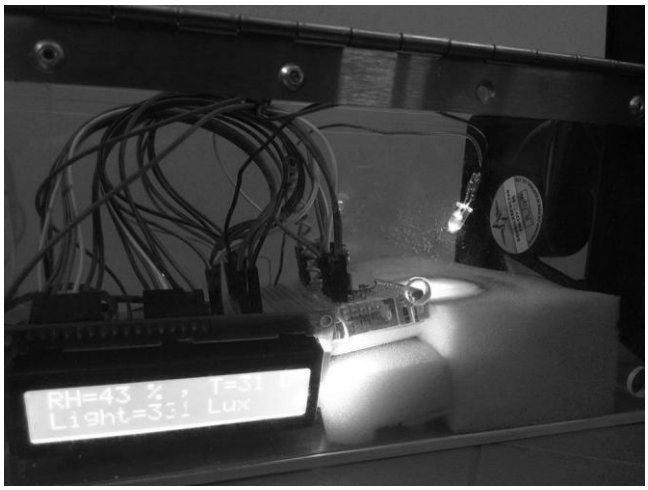

Figure3: Display status on LCD with mounted circuit.

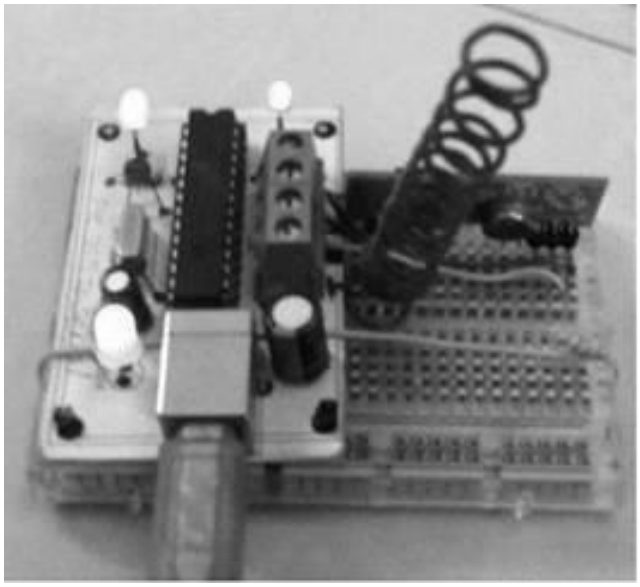

Figure4: USB to Serial converter with RX modular

Below the LabView represents the parameters value. In this graph green color shows the value of light intensity, white indicates humidity and red color indicates temperature. If this value is exceeding the range will be shown instability and can realize the incubator babies condition.

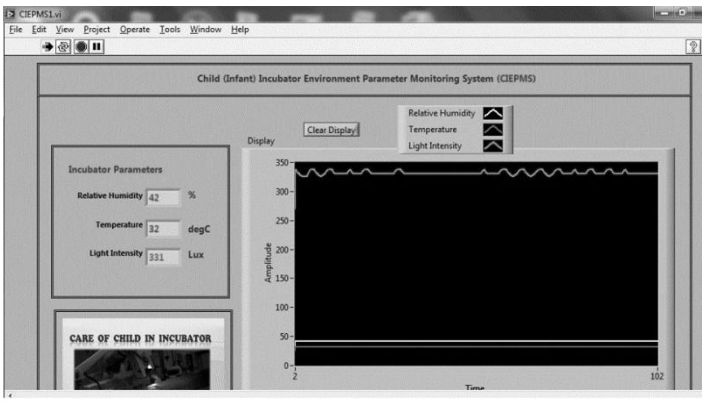

Figure5: LavView Software shows the status of an incubator

IV. SOFTWARE

A. LabView

LabVIEW is a system-design platform and development environment for a visual programming language from National Instruments [7]. The G programming language is central to LabVIEW; so much so that it is often called "LabVIEW programming." Using it, you can quickly tie together data acquisition, analysis, and logical operations and understand how data is being modified. From a technical standpoint, G is a graphical dataflow language in which nodes (operations or functions) operate on data as soon as it becomes available, rather than in the sequential line-by-line manner that most programming languages employ. The "flow" of data through the application can be laid out graphically with wires connecting the output of one node to the input of another.

B. Flowchart of Software Implementation

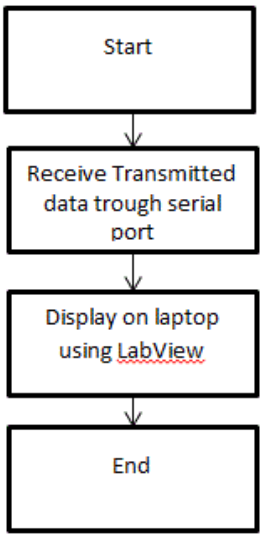

Figure6: Flow chart of RX software Development

C. BASCOM-AVR

This software is used to program the UNO Board. BASCOM-AVR is not only a BASIC Compiler, but also a comfortable Integrated Development Environment (IDE) running under Windows 95 and Windows NT [8]. Such a development environment supports the whole process from coding and testing a program to programming the microcontroller.

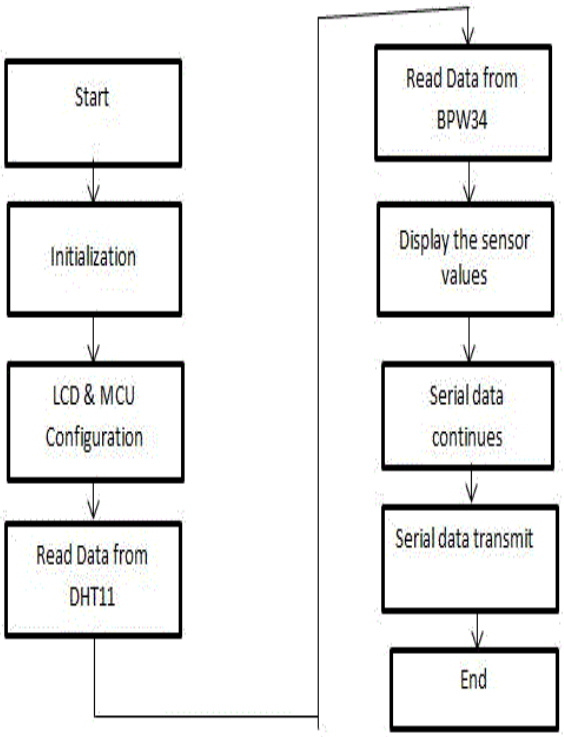

Figure7: Flowchart of TX software development

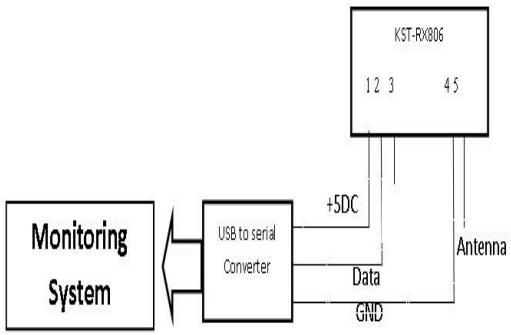

Figure8: The Connection with the Circuit of Receiving Part

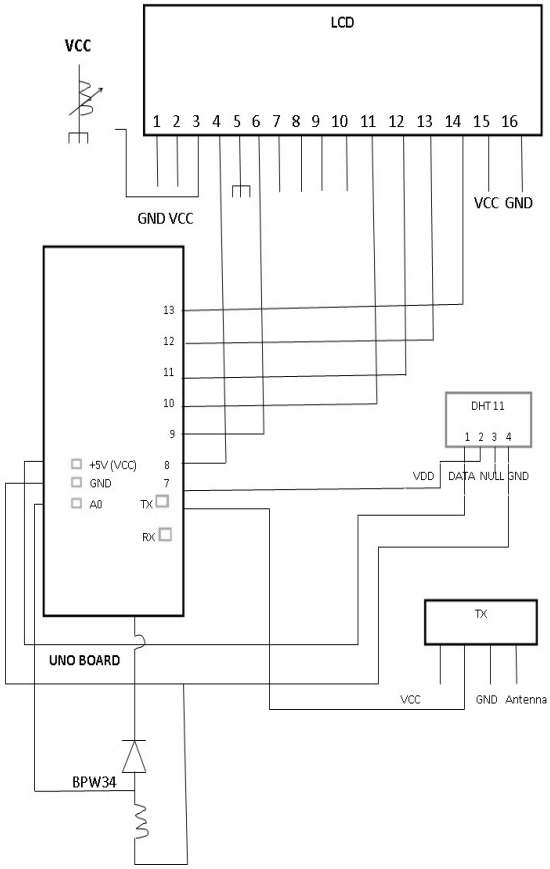

Figure9: Circuit Diagram of System Transmitting Part

C. Result and Decision

The proposed system gives a solution that enables monitoring of the overall condition premature babies. The parameters values represent the actual and real time condition. Using sensor we can get the accurate values and using device is less accurate. For example, a table is given below:-

Table2:- Comparison between Sensor data and device data

Thermometer	**Hygrometer**	**Light Intensity**	**DHT 11**	**BPW34**
29 degree Celsius	49.8% RH	250 lux	T= 31 Degree Celsius & RH=43 %	331 lux

V. CONCLUSIONS

This paper presented the development of a microcontroller-based integrated monitoring system for infant incubator. The main benefit of this system is cost effectiveness. It is not expensive to implement. The proposed system can play a

vital role in the cost effective design of life supporting units for the premature babies.

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